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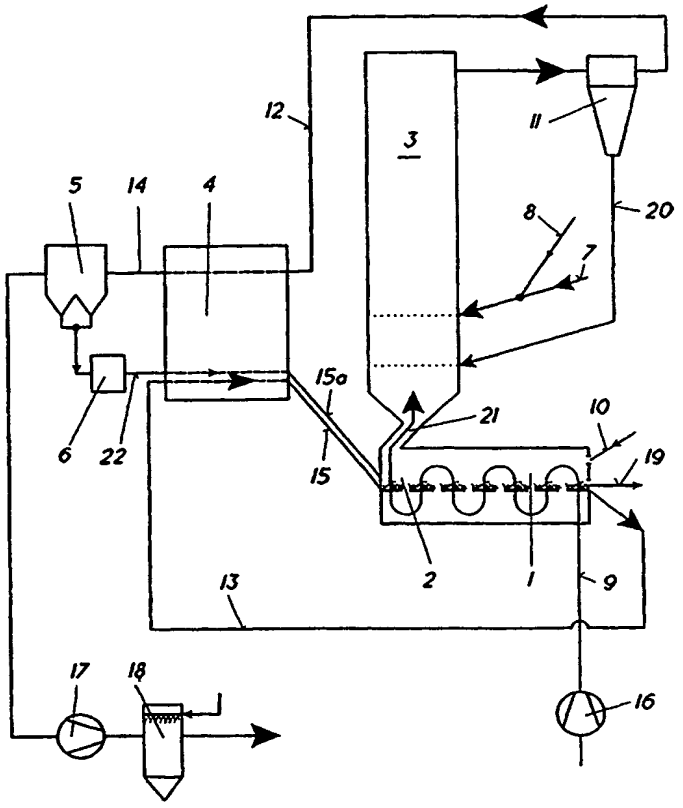
(54) Title: METHOD OF PRODUCING A CLEAN GAS FROM A HYDROCARBON

(57) Abstract

In a method of producing a clean gas from hydrocarbons, hot air and steam are mixed in a reaction zone with carbonaceous residue, whereby carbon reacts with oxygen to form CO_2 and CO under heat release. Hydrocarbon is added to release moisture and volatile and to have reacted volatile and carbon to CO and H_2, the sulfur of the hydrocarbon being mainly converted into H_2S. A sulfur sorbent is added and is converted into CaO, which CaO reacts with H_2S and COS to solid CaS. At the exit of the reaction carbonaceous residue is separated from the fluid and returned to the reaction zone. The gas is fed into a gas cooler, in which it is cooled by cold solids. The solids consist on one hand of ash being cooled with the air prior to the air entering into the reaction zone and on the other hand of ash and carbonaceous residue filtered out of the reduced gas downstream the gas cooler. The latter solids are size-enlarged prior to their entering the gas cooler.



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Method of producing a clean gas from a hydrocarbon

Field of the invention

The invention relates to a method of producing a clean gas in a reaction zone by mixing hot air and steam with carbonaceous residue, adding hydrocarbon to release moisture and volatile and to have reacted volatile and carbon to CO and H_2.

Discussion of Background

The production of fuel gas from hydrocarbon like coal is operated at the present time by injecting cold reactants and/or steam into a gasifier and transferring a major portion of the sensible heat in the gasification products to a water/steam mixture. This is necessary to enable reliable operation of downstream gas cleaning equipment. Consequently the conversion of coal to the product gas in terms of the energy content is not maximized.

Summary of the invention

Accordingly, one object of the invention is to provide a novel method and plant which maximizes the production of clean "reduced" gas from the feed hydrocarbon with minimal transfer of heat out of the involved system.

This is achieved, according to the invention, by means of the features of patent claims 1 and 10.

The advantages of the invention are to be seen, inter alia, in a considerable reduction of the plant and operating costs, due to a very high calorific value conversion and in the elimination of indirect contact heat exchangers.

Brief description of the invention

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing, which illustrates diagrammatically an exemplary embodiment of the invention with coal as hydrocarbon. Only the elements essential for understanding the invention are shown. Arrows illustrate the flow direction of the working media.

Description of the preferred embodiment

Referring now to the drawing, the equipment necessary for performing the gas production consists mainly of three blocks, namely a gasifying device 3, a gas/solid heat exchanger 4 and an combined ash cooler/oxidizer 1, 2.

Via a fan 16 ambient air is introduced in the ash cooler 1. In order to increase the amount of oxygen atoms and in the same time reduce the amount of air, water is also introduced into the cooler at its cold end via water supply 10. This water is evaporated in the air stream during its travel through the cooling device. This device may be a gas/solid heat exchanger of the grid type or of the fluid bed type. The air is heated up to about 500-900°C. The lower value is chosen, if it is intended to have a catalytic reaction further downstream. The solids entering the cooler 1 at its hot side consist mainly of inert ash, carbon and of CaS and CaO.

They have an inlet temperature of about 600°C and leave the cooler with a temperature of about 100°C. The size of the solids is at least approximately 500 µm which avoids particles being entrained with the air leaving the cooler at its hot end. By entering the apparatus 1, in an oxidizing sector 2 the unburned carbon and CaS particles are first oxidized by the hot air/steam mixture into CO_2 and $CaSO_4$. Other components of the hot material, i.e. unoxidized gases like CO, H_2S and COS as well as sulphided sorbents like CaS and FeS are also oxidized in this area. It might be that the unburned carbon and CaS particles are also oxidized by the hot air/steam mixture into CaO and SO_2. In order to avoid that significant amount of SO_2 penetrates in the following reactor, it is appropriate to arrange the heat exchanger surfaces and to have the air/steam mixture circulated in the sector 2 so as to obtain as a last process in the oxidizer always mainly $CaSO_4$.

From this oxidizing area 2, which is the hot side of the ash cooler 1, the air/steam mixture enters a reactor 3 via a hot air supply 21. Depending on the apparatus type, the mixture can be introduced into the reactor on different levels. In the example shown on the drawing, in which the reactor is an upright gasifier with a flow stream from bottom to top, the mixture is introduced at the bottom. The reactor is provided with two other inlets. One carbonaceous residue supply line 20 and one common inlet for coal 7 and sulfur sorbent 8.

In the present example the carbonaceous residue is char which is partially gasified coal. It enters the reactor 3 with a temperature of about 700°C. It reacts with the oxygen of the air/steam mixture to form CO_2/CO and releases heat.

Downstream of the char inlet, the coal to be gasified is introduced into the reactor 3. This coal can be either crushed or pulverized. Like the air, coal may be injected on different levels of the reactor. The same inlet is preferably used to introduce sulfur sorbent, which can be pulverized limestone or dolomite. Coal and sorbent may be transported by any suitable means, i.e. by steam; in a pre-

ferred embodiment, the produced reduced gas itself transports the solids. If the coal is in form of crushed material with a size of approximately 6 mm, it can be fed by gravity. The adding of coal in the reactor results in a moisture and volatile release. A reaction of volatile and carbon occurs with the steam, the CO_2 and remaining O_2 (if any) to form CO and H_2.

Thus at the exit of the reactor 3 there is mainly CO and H_2 to be found together with N_2 from the air and trace amounts of CO_2 and H_2O in vapor form. Also present are char and ash. The temperature at the exit of the reactor is in the range of 400-700°C, again depending on the entry temperature of the air due to any possible catalytic treatment downstream.

If limestone is used as a sulfur sorbent in the reactor, $CaCO_3$ is converted into CaO. The sulfur in the coal is converted mainly into H_2S and in trace quantities into COS. Most of the H_2S and COS react with CaO to form solid CaS. Thus at the exit of the reactor, the calcium sorbent is present as CaS and CaO.

Downstream the reactor a particulate separation device 11 is provided. This separator could be a cyclone designed to separate the predominant char from the remaining components. Since the size of the ash is typically smaller than 30μm it will escape the cyclone, while the char, which is greater than 100μm, will be retained in the cyclone. This separated char is returned via the supply line 20 into the reactor, while the remaining components, especially the reduced gas is forwarded to a gas cooler 4.

The reduced gas is supposed to leave the gas cooler 4 with a temperature of about 200°C. Downstream the gas cooler a solids filter 5 is provided in the line 14 to remove from the gas fine ash and char, as well as CaS and CaO that has not been separated in the gas cooler 4. This filter is supposed to remove all the remaining solids from the gas.

A further fan 17 is installed in the gas line 14, preferably on the clean side of the filter 5. Its purpose is to control the pressure in the system close to atmospheric conditions.

Depending on the utilization of the gas, a further gas cooler 18 may be provided in the gas line 14 downstream the fan 17, if a wet electrostatic participator has not been used upstream as a filtering element. To cool the gas down to 30°C, it is recommended to use a water spray cooler.

The filter 5 could be a fabric filter, an electrostatic participator or a wet electrostatic participator. The use of the latter provides following advantages: beside the particulate removal a further cooling of the gas, the removal of ammonia, tar and hydrogen cyanide that might have been produced in the reactor 3.

The further treatment of the solids removed from the filter 5 is a major feature of the present invention.

The gas cooler 4 is a gas/solids heat exchanger and might be constituted of a series of cyclones. Therein solids and gas flow in a predominating counter-current manner. The minor part of cold solids fed into the gas cooler is taken from the exit of the filter 5 via feed line 22. As the size of the solids exiting the filter is smaller than 50µm, they have to be size-enlarged in order to enable retention within the cyclones. This agglomeration occurs in a pelletizer 6, in which pellets having a size of approximately 1-5 mm are produced. The solids are introduced in the gas cooler 4, in which they are heated up to about 600°C. At the exit of the gas cooler, they are fed into the ash cooler 1 via the heated solids line 15a.

In a preferred embodiment, the major part of cold solids to be fed into the gas cooler are solids exiting the ash cooler 1 being recycled unchanged into the gas

cooler 4 via 13. This means that only the solids exiting the filter 5 have to be pelletized. This is based on the fact, that the size of the solids being cooled down in the ash cooler 1 is great enough to be retained in the gas cooler 4 while flowing through the series of cyclones. As shown in the drawing, accordingly both solids from filter 5 and from ash cooler 1 are separately introduced in the gas cooler. Moreover they each cross the gas cooler in a separate path being each heated up therein to about 600°C. The separate paths are maintained as a heated solids line 15, 15a throughout the further flow of this solids.

Due to the permanent adding of coal and sulfur solvent during operation, an equivalent amount of solids has to be removed from the system. This occurs preferably in a disposal line 19 connected to the exit of the ash cooler 1.

As described below in an example, the amount of the solids exiting the filter 5 and flowing through line 15a corresponds approximately to the amount of material to be disposed. Accordingly it is preferable to also keep separated by a partition this solids from the main solids flow in line 15 within its travel through the ash cooler 1 and to dispose it via the line 19.

The invention may be illustrated in more detail with reference to a numerical example: it goes without saying that absolute values cannot be specified in connection with the said numerical values with regard to the dimensioning of the involved apparatus and in particular the reactor and the gas cooler, since absolute values are in any case not meaningful enough on account of their dependence on all too numerous parameters. The sole determining factor for the design is that minimal transfer of heat out of the involved system is realized.

The amount of injected coal via line 7 be 19.5 kg/sec, the coal having a lower heating value of about 25 MJ/Kg and containing about 2.5 kg H_2O. The amount of injected sulfur sorbent, i.e. limestone via line 8 be 3 kg/sec. Via a fan 16, about 45 kg/sec of air are sucked in the system. Water in the amount of 5 kg/sec

is added at the cold side of the ash cooler via water supply 10. All these components are introduced under ambient conditions.

The amount of circulated inert solids through the gas cooler 4 and the ash cooler 1 via path 13, 15 is about 75 kg/sec. The amount of solids captured at the exit of filter 5, pelletized and transported through the gas cooler and the ash cooler in an own path 15a and disposed via the line 19 is about 5.5 kg/sec. It is assumed that 0.5 kg/sec of this solids are burned out during oxidation in the ash cooler and flow as a gas into the reactor 3, thus remaining in the cycle.

As a result the reduced product gas downstream the fan 17 is at an amount of about 67.5 kg/sec, the gas having a heat value of 6.7 MJ/kg. A small amount of the product gas is kept in the system as a transportation means for the pulverized coal and sorbent.

Instead of introducing the whole amount of hydrocarbon into the reactor, in a first variant of the invention, a small amount of the hydrocarbon, i.e. coal might be injected in a burner located in the ash cooler. This feature allows a temperature control within the ash cooler.

In a second variant, the sorbent, i.e. limestone or dolomite might be injected into the ash cooler instead into the reactor 3. If this sorbent is pulverized, the size must be fine enough to be entrained by the air stream. Again $CaCO_3$ is converted into CaO; a small portion of unreacted CaO forms $CaSO_4$ with SO_2 in the ash cooler. This feature allows calcining the sorbent and providing a longer residence time for CaO inside the downstream reactor 3, which improves the sulfur capture.

In a further variant, the air/steam mixture as well as the coal might be introduced into the reactor at several different locations, which allows a better temperature control inside the reactor and a still higher conversion efficiency.

Of course, the invention is not restricted to the plant shown and described. The invention can be used irrespective of the type and design of the reactor. This reactor could be as well an apparatus with entrained flow, if a pulverized fuel is used or with fluidized bed, if crushed fuel is used. Instead of cyclones, separating apparatus with moving bed could be used as well.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

LIST OF DESIGNATIONS

1	air heater (gas/solid heat exchanger)
2	Oxidizer
3	Gasifier
4	reduced gas cooler
5	solid filter
6	pelletizer
7	coal feed line
8	sulfur sorbent line
9	air supply
10	water supply
11	particulate separation device, cyclone
12	hot gas line
13	cold solids line
14	cold gas line
15	heated solids line
16	pushing fan
17	pulling fan
18	gas cooler
19	removal of ash
20	carbonaceous residue supply line
21	hot air supply to 3
22	feed line from 5 to 4

Claims

1. A method of producing a clean gas from hydrocarbons, comprising the steps of
   - in a reaction zone mixing hot air and steam with carbonaceous residue whereby carbon reacts with oxygen to form CO_2 and CO under heat release, adding hydrocarbon to release moisture and volatile and to have reacted volatile and carbon to CO and H_2, the sulfur of the hydrocarbon being mainly converted into H_2S, adding a sulfur sorbent being converted into CaO, which CaO reacts with H_2S and COS to solid CaS,
   - at the exit of the reaction zone separating at least the predominant of the carbonaceous residue from the fluid and returning it to the reaction zone,
   - feeding the gas into a gas cooler, in which it is cooled preferably in countercurrent by cold solids, the solids consisting on one hand of ash being cooled with the air prior to the air entering into the reaction zone and on the other hand of ash and carbonaceous residue filtered out of the reduced gas downstream the gas cooler, the latter solids being size-enlarged prior to their entering the gas cooler .

2. A method according to claim 1, characterized in that the hydrocarbon and the sulfur sorbent are commonly injected into the reaction zone.

3. A method according to claim 2, characterized in that the hydrocarbon and the sulfur sorbent are pulverized and are transported by means of the produced reduced gas.

4. A method according to claim 1, characterized in that steam is produced by introducing water into a heat exchanging zone upstream the reaction zone, where the water evaporates in the air stream, the air stream being heated by the hot solids exiting the gas cooler and the air/steam mixture oxidizing unburned carbon, sulphided sorbent and unoxidized gases.

5. A method according to claim 4, characterized in that some of the hydrocarbon is injected into a burner of the heat-exchanging zone.

6. A method according to claim 4, characterized in that the sulfur sorbent is introduced into the heat-exchanging zone.

7. A method according to claim 1, characterized in that the air/steam mixture as well as the hydrocarbon is fed into the reaction zone in at least one location.

8. A method according to claim 1, characterized in that the air heating/solids cooling, the reaction with hydrocarbon and sulfur sorbent, the solids separation, the gas cooling/solids heating and the filtering is performed under at least approximately atmospheric pressure.

9. A method according to claim 1, characterized in that the ash filtered out of the reduced gas downstream the gas cooler is disposed after having being heated in the gas cooler and cooled in the heat exchanging zone upstream the reaction zone.

10. A plant for performing the method according to claim 1 comprising
- a hydrocarbon feed line (7), a sulfur sorbent feed line (8), a hot air supply (21) and a carbonaceous residue supply line (20), all connected to a reactor (3), the exit of the reactor (3) being connected to a particulate separation device (11),
- a gas cooler (4) being connected at it's inlet side via a hot gas line (12) to the exit of the particulate separation device (11) and via a cold solids line (13, 22) to a solids supply, and being connected at it's outlet side via a cold gas line (14) to a solids filter (5) and via a heated solids line (15, 15a) to a gas/solids heat exchanger (1),
- the solids outlets of the filter (5) and of the gas/solids heat exchanger (1) forming the solids supply to the gas cooler (4).

11. A plant according to claim 10, characterized in that the gas/solids heat exchanger (1) comprises an oxidizer (2) at its hot end.

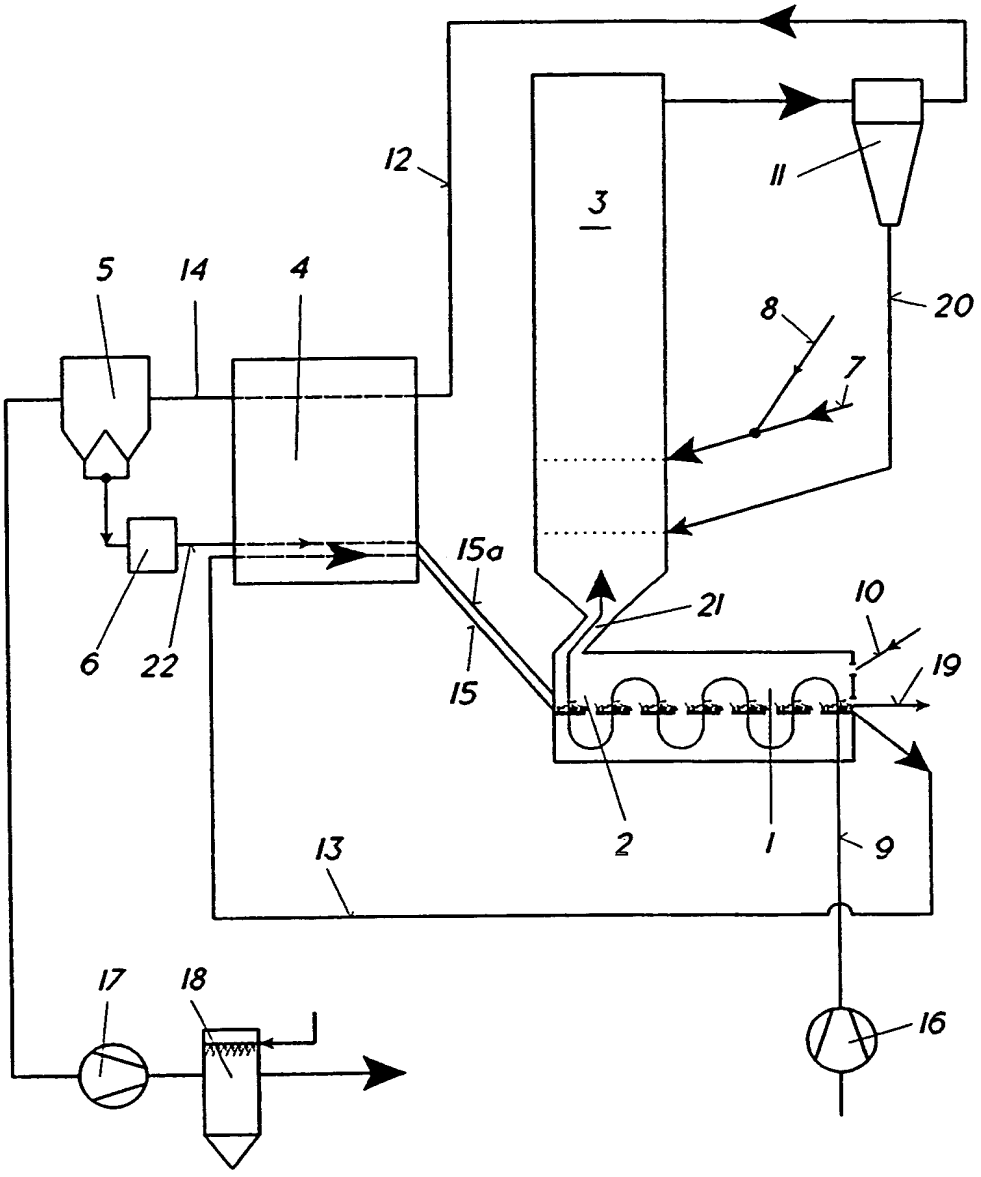
12. A plant according to claim 10, characterized in that the gas/solids heat exchanger (1) comprises from it's inlet to it's outlet two solids flow paths separated by a partition and being fed each with solids from a separate heated solids line (15, 15a).

13. A plant according to claim 10, characterized in that the gas cooler (4) comprises a series of cyclones.

14. A plant according to claim 10, characterized in that a solids size-enlarging apparatus (7) is provided in the feed line (22) between the solids outlet of the filter (5) and the inlet of the gas cooler (4).

15. A plant according to claim 10, characterized in that pressure control in the system is performed by a fan (17) installed in the cold gas line (14) downstream the filter (5).

16. A plant according to claim 10, characterized in that the filter (5) is a wet electrostatic participator.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INTERNATIONAL SEARCH REPORT

Inte ional Application No
PC1/CH 99/00313

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10J3/84 C10J3/54 C10J3/56

According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 4 198 212 A (TSAO) 15 April 1980 (1980-04-15) the whole document	1,9
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 September 1999	06/10/1999

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/CH 99/00313

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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EP 227197 A	01-07-1987	NONE	

PATENT COOPERATION TREATY

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KLEIN, Ernest
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(PCT Rule 24.2(a))

Date of mailing (day/month/year)	IMPORTANT NOTIFICATION
10 August 1999 (10.08.99)	
Applicant's or agent's file reference	**International application No.**
98/124 wo	PCT/CH99/00313

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

"PATELHOLD" PATENTVERWERTUNGS- & ELEKTRO-HOLDING AG (for all designated States except US)
TOQAN, Majed et al (for US)

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Date of receipt of the record copy by the International Bureau	:	20 July 1999 (20.07.99)
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ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

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- [X] confirmation of precautionary designations
- [X] requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer:

Ingrid Autich

Telephone No. (41-22) 338.83.38

Eingang 29.03.00 Ke

OA

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

INFORMATION CONCERNING ELECTED OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

To:

KLEIN, Ernest
Sandstrasse 24
CH-5416 Kirchdorf
SUISSE

Date of mailing (day/month/year) 20 March 2000 (20.03.00)	
Applicant's or agent's file reference 98/124 wo	**IMPORTANT INFORMATION**
International application No. PCT/CH99/00313	**International filing date** (day/month/year) 09 July 1999 (09.07.99)
Priority date (day/month/year) 29 July 1998 (29.07.98)	
Applicant "PATELHOLD" PATENTVERWERTUNGS- & ELEKTRO-HOLDING AG et al	

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

   AP :GH,GM,KE,LS,MW,SD,SL,SZ,UG,ZW
   EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE
   National :AU,BG,BR,CA,CN,CZ,DE,IL,JP,KP,KR,MN,NO,NZ,PL,RO,RU,SE,SK,US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

   EA :AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
   OA :BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG
   National :AE,AL,AM,AT,AZ,BA,BB,BY,CH,CU,DK,EE,ES,FI,GB,GD,GE,GH,HU,ID,IN,
   IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MW,MX,PT,SD,SG,SI,SL,TJ,TM,TR,
   TT,UA,UG,UZ,VN,YU,ZA,ZW

3. The applicant is reminded that he must enter the "national phase" **before the expiration of 30 months from the priority date** before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing , if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

   Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

   The entry into the European regional phase is postponed **until 31 months from the priority date** for all States designated for the purposes of obtaining a European patent.

Frist 29.1.01 | SB

Agenda: bereits erledigt

SLE-I Eingang 31. MRZ. 2000 | Ablage:

SB | Visa

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland** Facsimile No. (41-22) 740.14.35	Authorized officer: Juan Cruz Telephone No. (41-22) 338.83.38

3174713

Form PCT/IB/332 (September 1997)

PATENT COOPERATION TREATY

REC'D 30 MAY 2000

WIPO PCT

PCT

16

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
98/124 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CH99/00313	09/07/1999	29/07/1998
International Patent Classification (IPC) or national classification and IPC C10J3/84		
Applicant "PATELHOLD" PATENTVERWERTUNGS- & ELEKTRO-... et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
25/02/2000	26.05.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Hoefer, R Telephone No. +49 89 2399 8401

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CH99/00313

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-4,7,8	as originally filed
5,6	filed with the demand

Claims, No.:

1-14	as originally filed
15,16	filed with the demand

Drawings, sheets:

1/1	as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 1-16
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-16
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-16
	No:	Claims

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.) Reference is made to the following documents:

D1: GB-A 1 528 623
D2: EP-A 725 127

D1 and D2 describe methods for producing clean gas by gasification of coal in which methods the solid ash issuing from the reactor or the fly ash separated from the produced gas is cooled in an ash cooler thereby heating the air required in the gasification reactor. D1 further discloses the use of lime as sulfur adsorbent (D1: Figure; D2: Figures 1 and 2).

2.) The heat regeneration principle of the claimed invention, to use the solid material (ash and carbonaceous residue) in a loop for cooling the product gas as well as for heating the air prior to entering the reactor, is neither described nor derivable from the prior art.

It appears that the claimed invention allows to maximize the production of clean gas and to improve the thermal efficiency of the system.

Re Item VII

Certain defects in the international application

3.) Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 or D2 is not mentioned in the description, nor are these documents identified therein.

A further fan 17 is installed in the gas line 14, preferably on the clean side of the filter 5. Its purpose is to control the pressure in the system close to atmospheric conditions.

Depending on the utilization of the gas, a further gas cooler 18 may be provided in the gas line 14 downstream the fan 17, if a wet electrostatic precipitator has not been used upstream as a filtering element. To cool the gas down to 30°C, it is recommended to use a water spray cooler.

The filter 5 could be a fabric filter, an electrostatic precipitator or a wet electrostatic precipitator. The use of the latter provides following advantages: beside the particulate removal a further cooling of the gas, the removal of ammonia, tar and hydrogen cyanide that might have been produced in the reactor 3.

The further treatment of the solids removed from the filter 5 is a major feature of the present invention.

The gas cooler 4 is a gas/solids heat exchanger and might be constituted of a series of cyclones. Therein solids and gas flow in a predominating counter-current manner. The minor part of cold solids fed into the gas cooler is taken from the exit of the filter 5 via feed line 22. As the size of the solids exiting the filter is smaller than 50µm, they have to be size-enlarged in order to enable retention within the cyclones. This agglomeration occurs in a pelletizer 6, in which pellets having a size of approximately 1-5 mm are produced. The solids are introduced in the gas cooler 4, in which they are heated up to about 600°C. At the exit of the gas cooler, they are fed into the ash cooler 1 via the heated solids line 15a.

In a preferred embodiment, the major part of cold solids to be fed into the gas cooler are solids exiting the ash cooler 1 being recycled unchanged into the gas

cooler 4 via 13. This means that only the solids exiting the filter 5 have to be pelletized. This is based on the fact, that the size of the solids being cooled down in the ash cooler 1 is great enough to be retained in the gas cooler 4 while flowing through the series of cyclones. As shown in the drawing, accordingly both solids from filter 5 and from ash cooler 1 are separately introduced in the gas cooler. Moreover they each cross the gas cooler in a separate path being each heated up therein to about 600°C. The separate paths are maintained as a heated solids line 15, 15a throughout the further flow of this solids.

Due to the permanent adding of coal and sulfur sorbent during operation, an equivalent amount of solids has to be removed from the system. This occurs preferably in a disposal line 19 connected to the exit of the ash cooler 1.

As described below in an example, the amount of the solids exiting the filter 5 and flowing through line 15a corresponds approximately to the amount of material to be disposed. Accordingly it is preferable to also keep separated by a partition this solids from the main solids flow in line 15 within its travel through the ash cooler 1 and to dispose it via the line 19.

The invention may be illustrated in more detail with reference to a numerical example: it goes without saying that absolute values cannot be specified in connection with the said numerical values with regard to the dimensioning of the involved apparatus and in particular the reactor and the gas cooler, since absolute values are in any case not meaningful enough on account of their dependence on all too numerous parameters. The sole determining factor for the design is that minimal transfer of heat out of the involved system is realized.

The amount of injected coal via line 7 be 19.5 kg/sec, the coal having a lower heating value of about 25 MJ/Kg and containing about 2.5 kg H_2O. The amount of injected sulfur sorbent, i.e. limestone via line 8 be 3 kg/sec. Via a fan 16, about 45 kg/sec of air are sucked in the system. Water in the amount of 5 kg/sec

15. A plant according to claim 10, characterized in that pressure control in the system is performed by a fan (17) installed in the cold gas line (14) downstream the filter (5).

16. A plant according to claim 10, characterized in that the filter (5) is a wet electrostatic precipitator.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
98/123 WO		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/CH 99/ 00313	09/07/1999	29/07/1998

Applicant

PATELHOLD PATENTVERWERTUNGS & ELEKTRO-HOLDING AG

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

[ ] as suggested by the applicant.

[X] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CH 99/00313

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C10J3/84 C10J3/54 C10J3/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1 528 623 A (STORA KOPPABERGS BERGSLAGS) 18 October 1978 (1978-10-18) the whole document	1,2,7,8, 10
A	US 4 198 212 A (TSAO) 15 April 1980 (1980-04-15) the whole document	1,9
A	PATENT ABSTRACTS OF JAPAN vol. 006, no. 015 (C-089), 28 January 1982 (1982-01-28) & JP 56 139587 A (AGENCY OF IND SCIENCE & TECHNOL), 31 October 1981 (1981-10-31) abstract	1,4,9-11
A	EP 0 725 127 A (METALLGESELLSCHAFT) 7 August 1996 (1996-08-07) page 3, line 27-46	1

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 September 1999	06/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Meertens, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CH 99/00313

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 384 454 A (AHLSTRÖM CORP.) 29 August 1990 (1990-08-29) page 5, column 7, line 30 -page 6, column 9, line 10 ---	1,10,14
A	EP 0 227 197 A (SHELL) 1 July 1987 (1987-07-01) -----	

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/CH 99/00313

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB 1528623	A	18-10-1978	SE	390420 B	20-12-1976
			AU	497855 B	18-01-1979
			AU	8533675 A	07-04-1977
			CA	1093821 A	20-01-1981
			DE	2543500 A	15-04-1976
			FR	2286874 A	30-04-1976
			SE	7412370 A	02-04-1976
US 4198212	A	15-04-1980	NONE		
JP 56139587	A	31-10-1981	JP	1187032 C	20-01-1984
			JP	58017795 B	09-04-1983
EP 725127	A	07-08-1996	DE	19503438 A	08-08-1996
			AT	173005 T	15-11-1998
			DE	59600749 D	10-12-1998
EP 384454	A	29-08-1990	FI	890833 A	23-08-1990
			AT	80908 T	15-10-1992
			JP	1963951 C	25-08-1995
			JP	2290406 A	30-11-1990
			JP	6097082 B	30-11-1994
			US	4969930 A	13-11-1990
EP 227197	A	01-07-1987	NONE		

PATENT COOPERATION TREATY

Taste in PCT

Eingang 29.05.00

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

KLEIN, Ernest
Sandstrasse 24
5416 Kirchdorf
SUISSE

SLE-I Eingang 06. JUNI 2000 Ablage

SB 47 Ke

Visa

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	26.05.2000
Applicant's or agent's file reference 98/124 WO	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CH99/00313	09/07/1999	29/07/1998

Applicant
"PATELHOLD" PATENTVERWERTUNGS- & ELEKTRO-... et al

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Hundt, D Tel.+49 89 2399-8042

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
98/124 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CH99/00313	09/07/1999	29/07/1998
International Patent Classification (IPC) or national classification and IPC C10J3/84		
Applicant "PATELHOLD" PATENTVERWERTUNGS- & ELEKTRO-... et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
25/02/2000	26.05.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Hoefer, R Telephone No. +49 89 2399 8401

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CH99/00313

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-4,7,8	as originally filed
5,6	filed with the demand

Claims, No.:

1-14	as originally filed
15,16	filed with the demand

Drawings, sheets:

1/1	as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 1-16
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-16
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-16
	No:	Claims

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.) Reference is made to the following documents:

D1: GB-A 1 528 623
D2: EP-A 725 127

D1 and D2 describe methods for producing clean gas by gasification of coal in which methods the solid ash issuing from the reactor or the fly ash separated from the produced gas is cooled in an ash cooler thereby heating the air required in the gasification reactor. D1 further discloses the use of lime as sulfur adsorbent (D1: Figure; D2: Figures 1 and 2).

2.) The heat regeneration principle of the claimed invention, to use the solid material (ash and carbonaceous residue) in a loop for cooling the product gas as well as for heating the air prior to entering the reactor, is neither described nor derivable from the prior art.

It appears that the claimed invention allows to maximize the production of clean gas and to improve the thermal efficiency of the system.

Re Item VII

Certain defects in the international application

3.) Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 or D2 is not mentioned in the description, nor are these documents identified therein.

Copy for the Elected Office (EO/US)

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

PÖPPER, Evamaria
Alstom Power (Schweiz AG)
Intellectual Property CHSP
Haselstrasse 16/699
CH-5401 Baden
SUISSE

Date of mailing (day/month/year)
14 February 2001 (14.02.01)

IMPORTANT NOTIFICATION

Applicant's or agent's file reference
98/124 WO

International application No.
PCT/CH99/00313

International filing date (day/month/year)
09 July 1999 (09.07.99)

1. The following indications appeared on record concerning:

☐ the applicant ☐ the inventor ☒ the agent ☐ the common representative

Name and Address
KLEIN, Ernest
Sandstrasse 24
CH-5416 Kirchdorf
Switzerland

State of Nationality

State of Residence

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address
PÖPPER, Evamaria
Alstom Power (Schweiz AG)
Intellectual Property CHSP
Haselstrasse 16/699
CH-5401 Baden
Switzerland

State of Nationality

State of Residence

Telephone No.
+41 56 205 45 99

Facsimile No.
+41 56 205 66 20

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
☒ the elected Offices concerned
☐ other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer
J. Leitao

Telephone No.: (41-22) 338.83.38

003834956

MH

PCT/CH99/00313

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 20 March 2000 (20.03.00)	
International application No. PCT/CH99/00313	**Applicant's or agent's file reference** 98/124 wo
International filing date (day/month/year) 09 July 1999 (09.07.99)	**Priority date** (day/month/year) 29 July 1998 (29.07.98)
Applicant TOQAN, Majed et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

25 February 2000 (25.02.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS

Absender: ANMELDEAMT

PCT/PCT Rec'd 29 JAN 2001

An:

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MITTEILUNG DES INTERNATIONALEN AKTENZEICHENS UND DES INTERNATIONALEN ANMELDEDATUMS

(Regel 20.5 c) PCT)

Absendedatum (Tag/Monat/Jahr)
09.Juli 1999 (09.08.99)

Aktenzeichen des Anmelders oder Anwalts
98/124 wo

WICHTIGE MITTEILUNG

Internationales Aktenzeichen	Internationales Anmeldedatum (Tag/Monat/Jahr)	Prioritätsdatum (Tag/Monat/Jahr)
PCT/CH 99/00313	09.Juli 1999 (09.07.99)	29.Juli 1998 (29.07.98)

Anmelder
"Patelhold" Patentverwertungs- & Elektro-Holding AG c/o Kurt Brunner, 8750 Glarus.

Bezeichnung der Erfindung
Method of producing a clean gas from a hydrocarbon.

	Vis.	Dat.
P'schrift		
P'regleter	JJ	4.8
Taxen		
Mappe		
Computer	JJ	4.8.

1. Dem Anmelder wird mitgeteilt, dass der internationalen Anmeldung das oben genannte internationale Aktenzeichen und internationale Anmeldedatum zuerkannt worden ist

2. Weiterhin wird dem Anmelder mitgeteilt, dass das Aktenexemplar der internationalen Anmeldung

☒ dem Internationalen Büro am 16.07.99 übermittelt wird.

☐ dem Internationalen Büro noch nicht übermittelt wurde,

☐ weil die erforderliche Überprüfung zum Schutz der nationalen Sicherheit noch nicht erfolgt ist.

☐ weil (Angabe des Grundes):

☒ Ein Exemplar dieser Mitteilung ist dem Internationalen Büro übersandt worden (da das Aktenexemplar dem Internationalen Büro noch nicht übermittelt wurde). *

* Das Internationale Büro überwacht die Übermittlung des Aktenexemplars durch das Anmeldeamt und unterrichtet den Anmelder über dessen Eingang (mit Formblatt PCT/IB/301). Ist das Aktenexemplar bei Ablauf des vierzehnten Monats nach dem Prioritätsdatum noch nicht eingegangen, teilt das Internationale Büro dies dem Anmelder mit (Regel 22.1 c)).

Name und Postanschrift des Anmeldeamts	Bevollmächtigter Bediensteter
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Formblatt PCT/RO/105 (Juli 1992)

A further fan 17 is installed in the gas line 14, preferably on the clean side of the filter 5. Its purpose is to control the pressure in the system close to atmospheric conditions.

Depending on the utilization of the gas, a further gas cooler 18 may be provided in the gas line 14 downstream the fan 17, if a wet electrostatic participator has not been used upstream as a filtering element. To cool the gas down to 30°C, it is recommended to use a water spray cooler.

The filter 5 could be a fabric filter, an electrostatic participator or a wet electrostatic participator. The use of the latter provides following advantages: beside the particulate removal a further cooling of the gas, the removal of ammonia, tar and hydrogen cyanide that might have been produced in the reactor 3.

The further treatment of the solids removed from the filter 5 is a major feature of the present invention.

The gas cooler 4 is a gas/solids heat exchanger and might be constituted of a series of cyclones. Therein solids and gas flow in a predominating counter-current manner. The minor part of cold solids fed into the gas cooler is taken from the exit of the filter 5 via feed line 22. As the size of the solids exiting the filter is smaller than 50µm, they have to be size-enlarged in order to enable retention within the cyclones. This agglomeration occurs in a pelletizer 6, in which pellets having a size of approximately 1-5 mm are produced. The solids are introduced in the gas cooler 4, in which they are heated up to about 600°C. At the exit of the gas cooler, they are fed into the ash cooler 1 via the heated solids line 15a.

In a preferred embodiment, the major part of cold solids to be fed into the gas cooler are solids exiting the ash cooler 1 being recycled unchanged into the gas

cooler 4 via 13. This means that only the solids exiting the filter 5 have to be pelletized. This is based on the fact, that the size of the solids being cooled down in the ash cooler 1 is great enough to be retained in the gas cooler 4 while flowing through the series of cyclones. As shown in the drawing, accordingly both solids from filter 5 and from ash cooler 1 are separately introduced in the gas cooler. Moreover they each cross the gas cooler in a separate path being each heated up therein to about 600°C. The separate paths are maintained as a heated solids line 15, 15a throughout the further flow of this solids.

Due to the permanent adding of coal and sulfur solvent during operation, an equivalent amount of solids has to be removed from the system. This occurs preferably in a disposal line 19 connected to the exit of the ash cooler 1.

As described below in an example, the amount of the solids exiting the filter 5 and flowing through line 15a corresponds approximately to the amount of material to be disposed. Accordingly it is preferable to also keep separated by a partition this solids from the main solids flow in line 15 within its travel through the ash cooler 1 and to dispose it via the line 19.

The invention may be illustrated in more detail with reference to a numerical example: it goes without saying that absolute values cannot be specified in connection with the said numerical values with regard to the dimensioning of the involved apparatus and in particular the reactor and the gas cooler, since absolute values are in any case not meaningful enough on account of their dependence on all too numerous parameters. The sole determining factor for the design is that minimal transfer of heat out of the involved system is realized.

The amount of injected coal via line 7 be 19.5 kg/sec, the coal having a lower heating value of about 25 MJ/Kg and containing about 2.5 kg H_2O. The amount of injected sulfur sorbent, i.e. limestone via line 8 be 3 kg/sec. Via a fan 16, about 45 kg/sec of air are sucked in the system. Water in the amount of 5 kg/sec

15. A plant according to claim 10, characterized in that pressure control in the system is performed by a fan (17) installed in the cold gas line (14) downstream the filter (5).

16. A plant according to claim 10, characterized in that the filter (5) is a wet electrostatic participator.